

Prevalence of tenosynovitis and other injuries of the upper extremities in repetitive work

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LUOPAJÄRVI, T., KUORINKA, I., VIROLAINEN, M. and HOLMBERG, M. Prevalence of tenosynovitis and other injuries of the upper extremities in repetitive work. *Scand. j. work environ. & health* 5 (1979): suppl. 3, 48—55. The purpose of this investigation was to compare the prevalence of soft tissue disorders in the neck, arms and hands between packers doing repetitive work and shop assistants with variable tasks. One hundred and fifty-two female assembly-line packers in a food production factory and 133 female shop assistants were interviewed about their symptoms and given a clinical examination of the neck and upper extremities. The number of cases of tension neck, cervical syndrome, scalenus syndrome, and humeral epicondylitis did not differ significantly between the two groups. The prevalence of tenosynovitis and humeral tendinitis was significantly higher for the assembly-line packers. The packing work consisted of static muscle work by the arms, grasping and maximal extensions of the fingers, and lateral deviations of the wrists. The movements numbered up to 25,000/workday. A relationship between some work load factors and some disorders of the upper extremities is probable.

Key words: repetitive work, tenosynovitis, upper extremity injuries.

The mechanization of industrial work has decreased the physical work load of the jobs involved, while the proportion of repetitive manual tasks has often increased, especially in the so-called semi-mechanized phase (16). The work situations are monotonous, and loading concentrates on the musculature of the hands and arms. In Finland, chemical, textile and food production are typical of such semimechanized industries. Also the number of upper extremity diseases and neck complaints has been increasing in these industries. According to the Finnish Occupational Disease Register, the most common occupational diseases of the musculoskeletal

system are carpal tenosynovitis and humeral epicondylitis. The situation is not only peculiar to Finland. The existence of similar problems has also been reported in investigations concerning cash register operators (13, 15) and assembly plant workers (11) in Japan, and telegraphers and process workers in Australia (6, 7). Some work load factors such as fast repetitive or unaccustomed movements or distensions or contusions of the wrists have been described as causative factors. However most of these investigations (9, 14, 18) have been based on patient series without reference groups. Thus it is difficult to draw conclusions on the relationship between the symptoms and work.

The purpose of the present investigation was to examine and compare the health

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status of the neck and upper extremities of two occupational groups: assembly-line packers in a food production factory and shop assistants with variable tasks.

SUBJECTS AND METHODS

The subjects comprised 163 female assembly-line packers in a food production factory and, as a reference group, 143 female shop assistants.

The examined 163 packers represented 84 % of the package department's personnel. Thirty-three workers were not examined (17 were on sick leave, 11 refused and 5 were on vacation). In four cases the cause of sick leave was hand disease. In 13 cases the sickness was unrelated to the investigated problem. When the results were analyzed, 11 more workers were excluded for the following reasons: trauma to the hand within the last two years (5 cases), seropositive rheumatoid arthritis (4 cases), operated breast cancer (1 case), and neurological disease (1 case). The final study group consisted of 152 women having a mean age of 39 years ($SD \pm 9.3$, range 21–58 years) and an average length of employment on the assembly line of 6 years ($SD \pm 1.5$, range 3–7 years). Because of the short time the factory had been operating, there was no essential association between the age and length of employment. The most common prior jobs for the subjects had been housewife, shop assistant or farm worker.

The shop assistants worked in different shops of a big department store in the same town. Cashiers were not included. During the analysis of the results, 10 workers were excluded for the following reasons: seropositive rheumatoid arthritis (5 cases), recent hand injury (3 cases), operated breast cancer (1 case), or kidney disease with joint complaints (1 case). The final reference group consisted of 133 women who exhibited a direct relationship between age and length of work period. Their mean age was 39 years ($SD \pm 10.9$, range 18–60 years) and the average time spent as a shop assistant was 13 years ($SD \pm 9.7$, range 1–37 years).

Clinical examination

Methods for epidemiologic surveys of musculoskeletal diseases are few, and there is no generally accepted pattern. The method employed for the clinical examination in this investigation was based on the clinical experience of orthopedic, physiatric and occupational health specialists and on pertinent literature (2, 3, 4, 5). Its purpose was not to find a defined diagnosis for treatment, but to screen out, in two occupational groups, disorders which might indicate the effect of work load on the neck, arms and hands. The method is described elsewhere (22). The medical history, as well as some personal and daily life characteristics such as present health, social background, amount of housework and hobbies, were ascertained in an interview. Systematized examinations (active and passive test movements, isometric muscle tests, measurements, palpations and observations) were performed by a physiotherapist specially trained at the Institute of Occupational Health. The weekdays on which the study subjects and referents were examined were randomized so that any possible acute work load effect would be balanced. The physiotherapist recorded the findings, but the syndromes were diagnosed afterwards according to criteria predetermined by the group of specialists.

Statistical methods

When the relative frequencies were compared in the study and referent groups, the chi-square test was applied. When the statistical significance of the predominance of location, e.g., extensors or flexors or the right or left hand, was estimated, the McNemar test was applied. The risk probabilities rejecting the null hypothesis were calculated as two-tailed probabilities (p).

RESULTS

In the analysis of the results the syndromes were concentrated into four anatomic regions, the neck, shoulders, elbows

and wrists. The neck and upper extremities of 45 packers (30 %) and of 84 shop assistants (63 %) were judged healthy. This difference was highly significant ($p < 0.001$). The number of packers with one syndrome was slightly higher than the corresponding number of shop assistants, but not significantly so. However, the health disturbances of the packers were also more severe, for the number of packers with two or more syndromes was significantly ($p < 0.001$) higher than the corresponding number of shop assistants (table 1). Among the factory workers the number of syndromes could be regarded as a Poisson variable according to Pearson's chi-square ($\chi^2_5 = 1.22$, NS), but not in the case of the shop assistants ($\chi^2_4 = 14.20$, $p < 0.01$).³ The average number of syndromes was 1.3 (SD ± 1.1) among the factory workers (the 95 % confidence interval being 1.1–1.4 according to the Poisson distribution) and 0.5 (SD ± 0.9) among the shop assistants. The distributions of the number of syndromes differed clearly in the study groups ($\chi^2_4 = 36.5$, $p < 0.001$).³

The number of syndromes per person increased slightly after the age of 35 years in both groups.

Twenty-five packers (16 %) and 30 shop assistants (22 %) stated that they had a chronic disease such as high blood pressure, lung or heart disease or stomach trouble. In the characteristics of their daily life there were no remarkable differences.

Neck

The most common neck syndrome in both occupational groups was tension neck, which was found in 57 packers (37 %) and in 37 shop assistants (28 %) (table 2). The mean age of the packers with tension neck was 40 years (range 21–56) and that of the shop assistants with the same syndrome was also 40 years (range 18–60 years). Twenty-two packers who had tension neck also had tenosynovitis of the hand. The shop assistants' neck syndromes did not relate especially to any other disease. The

³ Categories 4 and 5 were combined to ascertain the validity of the chi-square approximation.

occurrence of other neck diseases was sporadic in both groups. In all, the assembly-line packers had more neck syndromes than the shop assistants, but there was no statistical difference between the two groups. The packers had visited a doctor for neck complaints during the last year significantly ($p < 0.001$) more often (46 packers as compared to 12 shop assistants).

Shoulder

The shoulder disorders found were called humeral tendinitis (tendon of the biceps or supraspinous muscles) and the acromioclavicular syndrome. The prevalence of a shoulder disorder was significantly higher ($p < 0.05$) for the assembly-line packers than for the shop assistants. From the total of 23 occurrences, 5 were found in

Table 1. Number of disorders of the neck and upper extremities per person.

Disorders/ person	Assembly-line packers (N = 152)	Shop assistants (N = 133)
0	45 ***	84
1	54	34
2	30	9
3	16	4
4	6	1
5	1	1

*** $p < 0.001$.

Table 2. Syndromes found in the neck, shoulders and elbows of the assembly-line packers and shop assistants.

Syndrome	Assembly-line packers (N = 152)	Shop assistants (N = 133)
Tension neck	57	37
Cervical syndrome	1	3
Scalenus syndrome	5	—
Humeral tendinitis	14	5
Acromioclavicular syndrome	4	—
Lateral epicondylitis	4	3
Medial epicondylitis	5	—
Pronator teres syndrome	2	—

** $p < 0.01$.

shop assistants and 18 in factory workers (table 2). There was no regularity in the combined prevalence with any other musculoskeletal disorder. The mean age of the packers with a shoulder disorder was 43 years (range 23—56 years) and that of the corresponding shop assistants 44 years (range 33—60 years).

Elbow

The elbow disorders were lateral epicondylitis ("tennis elbow"), medial epicondylitis, and the pronator teres syndrome. The total number of humeral epicondylitis cases was 12, of which 9 were found in 8 packers and 3 in shop assistants (table 2). One packer had bilateral epicondylitis in her right arm.

Among the assembly line-packers there were five cases of medial epicondylitis and four cases of lateral epicondylitis (table 2). The shop assistants had lateral epicondylitis only. Epicondylitis never appeared as the only syndrome, but was combined with tension neck, scalenus syndrome, or tenosynovitis of the hand in both occupational groups. The two pronator teres syndromes of the packers were combined also with some other upper extremity disorder.

The mean age of the packers and shop assistants with an elbow disorder was 44.5 years (range 36—56 years) and 47 years (range 36—60 years), respectively.

The total number of shoulder and elbow disorders was significantly higher ($p < 0.01$) among the packers than among the shop assistants. There was no significant difference between the right and left side in the prevalence of any separate shoulder or elbow syndrome, but among the packers the total number of these syndromes on the right side was significantly ($21:8$ $p < 0.05$) higher than on the left side.

Hands

The muscle-tendon syndrome in forearms and hands was called tenosynovitis when it was located at the tendon sheath area of the dorsal or palmar side of the wrist and peritendinitis when it involved structures higher up in the forearm. Symptoms of

the carpal tunnel syndrome were also looked for.

These muscle-tendon affections were found in 85 assembly-line packers and 18 shop assistants ($p < 0.001$). Among the packers the prevalence of different syndromes was even higher because extensors and flexors were often affected simultaneously and the coexistence of tenosynovitis and peritendinitis was common (table 3). In five cases peritendinitis existed alone without affections in the tendon sheath area.

The packers had tenosynovitis of the extensors significantly ($p < 0.001$) more often than tenosynovitis of the flexors (table 4). The tenosynovitis of the extensors included carpal extensors and tendons of the thumb, and it was analyzed as one disorder. Fifteen packers had tenosynovitis simultaneously on both sides of the wrist.

The right hand of the assembly-line packers was affected in 45 % of the cases ($p < 0.05$), and both hands in 29 % (table 4). The shop assistants had significantly ($p < 0.001$) more symptoms in their left hand, but there was no difference between the extensors and flexors as to which was affected the most. Seven packers and five shop assistants were left-handed, but there was no correlation between preferred hand and the disorders.

Most of the tenosynovitis conditions were chronic with more or less acute symptoms. Among the packers 15 cases of acute tenosynovitis were found, of which 11 were in the right hand. Only one of the shop assistants' cases of tenosynovitis was in the acute stage.

Table 3. Muscle-tendon syndromes in the hands of the assembly-line packers and shop assistants.

Syndrome	Assembly-line packers (N = 152)	Shop assistants (N = 133)
Muscle-tendon syndrome	85 (56 %) ***	18 (14 %)
Tenosynovitis		
Extensors	67	8
Flexors	28	10
Peritendinitis		
Extensors	39	5
Flexors	26	4

*** $p < 0.001$.

Table 4. Location of the tenosynovitis found in the assembly-line packers and shop assistants.

		Assembly-line packers			Shop assistants		
		Left hand			Left hand		
		+	—	Total	+	—	Total
Right hand	+	25	36	61 *	1	3	4
Right hand	—	19	72	91	14 ***	115	129
Total		44	108	152	15	118	133
		Extensors			Extensors		
		+	—	Total	+	—	Total
Flexors	+	15	13	28	—	10	10
Flexors	—	52	72	124	8	115	123
Total		67 **	85	152	8	125	133

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The mean age of the packers and shop assistants with hand affections was 40 years (range 22–56 years) and 42 years (range 20–60 years), respectively.

During the previous year 42 packers and 4 shop assistants had been treated by a physician for tenosynovitis ($p < 0.001$).

The total number of separate pathological findings in the hands of the assembly-line packers was 197 in 95 persons. One hundred and thirteen findings occurred in the right hand. Of all the findings, 96 were located in the thumb region, 53 in the extensors and 48 in the flexors of the second through the fifth fingers. For the shop assistants the total number of findings was 44 in 27 persons. Of them, 22 were located in the thumb, 14 in the flexors, and 8 in the extensors of the second through the fifth fingers.

In the forearms the number of separate findings was 97 among the packers and 22 among the shop assistants.

The carpal tunnel syndrome is probably combined more often with tenosynovitis of the flexors. Four separate cases were found among the packers and none among the shop assistants.

Work load of assembly-line packing

Every workplace in the study was ergonomically analyzed by a group comprising a foreman, a worker, a labor safety officer, and an occupational physiotherapist. The work movements were videotaped and evaluated by a work study engineer and a physician.

The factory work consisted of operating hard bread sawing and packing machines and the finishing of packages. The work speed was dominated by the pace of the machine (60 packages/min). The work alternated between manual and mechanical phases. The workers should have rotated tasks throughout the day and worked for 0.5–2 h in each phase of the task. Every worker should have worked in all the jobs in her department, but the rotation was carried out incompletely and nonsystematically. For the investigation this situation was a disadvantage as the load factors could be pointed out only in general forms. However, some common overloading factors were found in most tasks:

(a) Repetitive motions at a high speed: fingers and hands had to be constantly used at the pace of the machine, up to 25,000 cycles per workday.

(b) Static muscle work: when the workers lifted bread from the carrier to the saw-line, they had to push bread sheets together to prevent them from falling apart, and the arm and shoulder muscles were statistically contracted.

(c) Extreme work positions of the hands: the thumb and fingers were maximally extended in many work phases, as the width of the bread packages, which the worker had to grasp, was about 140 mm. Also, in many phases there were either maximal extension, flexion or radial deviation movements of the wrists.

(d) Lifting: the loads lifted manually weighed from 200 g to 27 kg, the average amount lifted daily being about 5,000 kg in some tasks. The lifting heights varied from 19 to 160 cm.

In addition, nonfitting gloves made grasping more difficult. Furthermore, the workers were sometimes transferred temporarily to other production departments, where they had to do unfamiliar jobs and perform untrained work movements.

Shop work

The shop assistants worked in different shops of a big department store chain where they served the public. They had to stand all day, but otherwise the work was physically light. The movements of hands varied and were nonrepetitive. Cashiers were excluded from the investigation.

DISCUSSION

The assembly-line packers had significantly more, and more severe, disorders in the neck and upper extremities than shop assistants of the same age. However, they reported less chronic diseases, which may indicate that they did not exaggerate their problems. The assembly-line packers had visited a doctor significantly more often because of their neck and hand complaints. As both of the enterprises receive their medical care services in the same occupational health center, the greater number of visits made by the packers indicates a real difference in morbidity.

The most common neck and upper extremity disorders in this study were tension neck, humeral tendinitis and tenosynovitis/peritendinitis. The frequency of the other disorders was, including epicondylitis, low.

The prevalence of the investigated conditions in the population is poorly known as most surveys have been based on clinical material. In the literature the tension neck syndrome has been described with various criteria. A comparison between

different studies is therefore unjustified, and the results of the studies can be mentioned as general background only. Partridge and Duthie (17) found tension neck in 6–14 % of the population studied. Maeda (12) analyzed the frequency of occupational cervicobrachial disorders in Japan and found figures varying from 4 to 21 %, depending on the gradings of the syndromes. Ferguson (6), in Australia, found tension neck in 22 % of telegraphers; 42 % of the examined subjects had mild symptoms. In this study tension neck syndrome was found in 38 % of the assembly-line packers and in 28 % of the shop assistants, but the prevalence of more severe neck syndromes was insignificant. The tension neck syndrome was somewhat more common in the assembly-line packers, but not as much as could have been expected due to certain features of their work.

The humeral tendinitis in the present study included bicipital and rotator cuff tendinitis, the latter being manifest mainly as supraspinous tendinitis. According to the literature (21) these two syndromes form the great majority of all soft tissue lesions around the shoulder joint, but their etiology and prevalence in the population is poorly known.

In this study humeral tendinitis was found in 9 % of the factory workers, a figure significantly higher than the 4 % of the shop assistants. The prevalence is lower than, e.g., in Allander's epidemiologic survey (1). The chronic cases were confined to four acromioclavicular syndromes.

The prevalence of epicondylitis in the population is also unknown. In clinical material lateral epicondylitis, often called "tennis elbow," is much more common than medial epicondylitis. In our study the prevalence of epicondylitis was small compared, e.g., to the prevalence of tenosynovitis. However, the prevalence of medial and lateral epicondylitis was equal in size and may be connected with the constant overstrain of flexors in work.

The muscle-tendon affections of the hands contain several pathological-anatomic entities (10). In this study we refer mainly to tenosynovitis and peritendinitis. To our knowledge, no epidemiologic survey has yet clearly displayed the prev-

alence of these conditions in the population. In clinical material and occupational surveys attention is usually paid to the speed of repetitive movements, unaccustomed work, and traumas (14, 19, 20). Obolenskaja and Goljanitzki (14) referred to a follow-up study in which 189 tenosynovitis cases appeared in eight months among 700 tea packers whose work involved repetitive movements.

In our cross-sectional study we found tenosynovitis/peritendinitis in 53 % of the assembly-line packers and in 14 % of the shop assistants. The difference is definite and highly significant. Our findings confirmed the opinion of some other investigators (8, 19) that tenosynovitis often involves the structures in the forearm above the tendon sheath and in the muscle bellies. In most of our tenosynovitis cases the peritendinitis symptoms were found simultaneously. The majority of affections was in the extensors, which in many investigations (14, 19, 20) have been indicated to be the usual site, but also affections of the flexors were fairly common. Like medial epicondylitis this result might relate to the difficult grasping movements involved in the factory work. In some studies (10, 18) the affections have been mainly found in the right hand. In the present investigation the shop assistants, for some unknown reason, had more syndromes in their left hand. The packers had more syndromes in their right hand, but affections were also common on the left side and bilaterally, which is natural, as a great amount of the work is done with both hands.

The packing work was very demanding on the upper limbs, and the results clearly point to this fact. If one of the load factors in particular, high speed, extreme movements, static muscle work or common overstrain of the hands, is the cause of the disorders, it cannot be specifically identified because of the work rotation and other confounding factors. However, their combined effect seems to be the most harmful. A factor which may affect the results is the lack of selection of assembly-line packers due to the low work turnover. The exposure of assembly-line packers is thus chronic. The recently introduced job rotation does not decrease the effect.

Because the women in both groups were very similar with respect to social background, daily routine and surroundings, the reason for the majority of the disorders in the upper limbs of the factory workers seems to be connected with work load factors.

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